This guide describes the curriculum of the CSM Course.

Core Strategies for Mathematics (CSM) Syllabus

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ACE Learning Evaluations Recommendation

The American Council on Education recommends that colleges accept the Core Strategies for Mathematics (CSM) Certificate as **3 semester hours of quantitative reasoning credit at the lower division baccalaureate level,** and provides the following information to colleges:

Learning Outcomes:

- Perform difficult mental calculations and estimations with a strong intuitive sense of number relationships, scale and magnitude
- Interpret and analyze complex units and how they relate to problem solving, and understand and convert common units in English and metric systems, plan complex conversions, analyze unit requirements, and read and interpolate from measurement devices
- Understand the uses of measures of central tendency and analyze outliers, use data for prediction, determine relevance of information, and extract information from complex information sources and graphs
- Perform financial calculations, including calculate taxes and discounts in realistic invoice contexts, choose financial products, understand common business calculations, and calculate simple and complex interest

- Apply mathematical concepts in real-world contexts, including calculations with time, areas and perimeters, and person-hours and work requirements
- Develop problem-solving strategies including chunking and sequencing, use units to guide calculations, and perform operations using multiple logical operators
- Use symbolic thinking, including isolate variables through inverse operations, perform fundamentals of equation manipulation, and create mathematical models of real-life scenarios using linear and other two-variable equations

Instruction: The methods of instruction include computer-based training. The general course topics include math skills, literacy skills, problem-solving strategies, independent learning, persistence, attention to detail and carefulness, high personal expectations, and self-efficacy.

Assessment: The methods of assessment include formative assessments in an adaptive learning environment with a minimum passing score of 100 percent.

The full ACE Learning Evaluations recommendation can be found here.

Current articulation agreements

The full list of colleges with articulation agreements to accept the CSM Certificate for credit can be found at Earn college credit (smilabs.org).

Course titles to consider include, Quantitative Reasoning, Technical Mathematics, Mathematics for the Liberal Arts, and similar titles.

Evidence of Effectiveness

In a national evaluation of educational technology by SRI International, CSM showed the largest math and literacy gains relative to classroom instruction, as well as the highest student engagement compared to ALEKS (McGraw-Hill) and MyMathLab (Pearson). The full study is "Murphy, R., et al (2017). Evaluating Digital Learning for Adult Literacy and Numeracy, SRI International".

Students who took CSM also showed much higher rates of college matriculation and persistence and graduation in community college (Escobari, M, et al (2019). Realism About Reskilling , Brookings Institute, page 57).

About CSM

Curriculum Structure

There are 38 Core Skills that every student masters to complete the CSM Course and earn their CSM Certificate. The CSM Course also includes 56 Supporting Skills that students are directed to only if necessary, and uses adaptive learning technology to maintain every student in their zone of proximal development at all times.

The CSM curriculum covers a range of topics of differing mathematical levels, allowing students to: be reintroduced more elementary topics in order to build new or deeper intuitions; build mental math abilities on skills that are usually taught for paper calculations; or connect mathematical calculations to real-world contexts and problem solving.

The CSM Course generally takes 20-100+ hours to complete, based on the skill level of the student prior to CSM, and on how quickly they learn new skills.

Assessment Structure

CSM is designed to ensure a high level of mastery of all skills learned. Students must answer every set of questions 100% correctly. As many skills as possible are fill-in-the-blank, and those that are multiple choice have been linked together to ensure a probability of correctly guessing of no more than 1 in 81.

CSM is also designed to ensure that student mastery is durable over time. CSM uses a karate belt metaphor to bring students back to skills over weeks as they move from yellow to red belt, and finally to a black belt. Instead of just giving students a check mark and moving on, the student must reproduce the 100% mastery one or two weeks later, demonstrating that the skills acquisition is deep and durable.

Such mastery has two primary purposes: to help students develop the attention to detail required for such mastery, and to help students gain mathematics-related self-efficacy and intrinsic motivation related to mathematics.

Instructional Paradigm – Learning that goes beyond academic skills

In addition to quantitative reasoning, CSM works to build the skills, strategies, mindsets, behaviors, and feelings that will help students to be self-sufficient learners and successful in school, college, work, and life.

The High Performance competencies built in CSM include independent learning, persistence and resilience, high personal expectations, and self-efficacy. CSM is the first adaptive learning system that adds personalization in metacognition and non-cognitive skills to traditional skills-focused adaptive learning.

- CSM builds **learning strategies** such as deciding what lessons to read, when to read them, and how deeply to read them; meta-cognition and accuracy in self-assessment; planning and goal-setting; an exploration mindset; and more.
- CSM builds **learning behaviors** such as attention-to-detail, conscientiousness, persistence, self-reliance, resilience, and more.
- CSM builds student **affect** (feelings) and **self-identity**, including personal high expectations, growth mindset, intrinsic motivation, and most importantly **self-efficacy**: the belief that you can succeed when you set your mind to it.

Learning Objectives

CSM skills have several important characteristics:

- **Practical and broadly useful.** The curriculum was designed through a U.S. Department of Education grant to target skills that have a broad range of usefulness in work across a variety of business sectors and occupations. Within CSM, math skills are presented in real-world contexts that require extracting information from complex text and graphs, ensuring that students will be able to apply their skills.
- **Designed to build deep understanding**. Deep fluency with skills makes them transferable – when people encounter problems in their everyday lives, they need to feel confident that they can think the problem through, rather than just reaching for a procedure that might not be appropriate.

Numbering of Standards

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Number Sense and Mental Math

CSM's number sense, mental math, and estimation curricula develop a strong intuitive sense of number relationships, scale, and magnitude.

Fractions, Decimals, Percents	
NSMM.1	**Reduce even fractions** and **compare fractions** with unlike denominators
NSMM.2	Understand **place value from thousandths to millions**, and place numbers on number lines at various orders of magnitude, including interpolation
NSMM.3	**Convert** between common fractions, decimals, percents, and mixed numbers, and **compare** values of numbers in different formats
NSMM.4	**Calculate complements of percentages** *(e.g., if 84% of students in a school are present, what percent are absent?)*
Mental Arithmetic and Estimation	
NSMM.5	**Perform mental calculations ranging from hundredths through millions** (addition, subtraction, multiplication, division and percentage calculations)
NSMM.6	**Perform mental estimations ranging from hundredths through millions** (addition, subtraction, multiplication, division, and percentage estimations)
Advanced Percents	
NSMM.7	**Mentally translate large and small percents (>99% and <1%) into ratios**, requiring **complements** and mental calculations *(e.g., if 99.9% of keyboards do not have keys that stick, 1 in how many computers do have keys that stick?)*
Rounding	
NSMM.8	**Round to various levels of precision** (from hundredths to thousands), including **deciding the appropriate level of precision** according to the problem statement

NSMM.9	**Decide when to round to nearest, round up** *(e.g., if you need 3.2 packages of paper plates for the party, you need to buy 4 packages)*, **or round down** *(e.g., if a manufacturing facility produces enough cans to fill 10.6 crates, it will have 10 full crates)*
Exponents	
NSMM.10	Calculating **squares** and **cubes** of whole numbers and decimals
NSMM.11	**Relative sizes** of squares *(e.g., 80^2 is 100 times larger than 8^2)*
Order of Operations	
NSMM.12	Order of operations using **PEDMAS** (parenthesis, exponents, division, multiplication, addition, subtraction)

Units and Measurement

Units and Measurement are key STEM skills, yet most students often ignore units in their work, and even combine numerical values that are incommensurate (e.g., 10 feet + 3 yards = 13). Students on CSM learn common units, their relationships to each other, how to convert, and how to use units in problem solving.

English and Metric Units	
UM.1	Understand intuitively the relative magnitudes of **English and metric units of length**. Be able to place units from both systems on a single number line
UM.2	Understand intuitively the relative magnitudes **of English and metric units of weight**. Be able to place units from both systems on a single number line
UM.3	Understand intuitively the relative magnitudes of **English and metric units of volume**. Be able to place units from both systems on a single number line
Unit Conversions	
UM.4	**Convert between length units**, including English-English conversions, English-metric conversions, and metric-metric conversions
UM.5	**Convert between weight units**, including English-English conversions, English-metric conversions, and metric-metric conversions
UM.6	**Convert between volume units** including English-English conversions, English-metric conversions, and metric-metric conversions
UM.7	**Convert between area units**, including English-English conversions, English-metric conversions, and metric-metric conversions
UM.8	**Check answers** in length, weight, volume and area conversions based on the magnitude of the units *(e.g., if you are converting inches to feet, you should have fewer feet than inches)*
Measurement Devices	
UM.9	**Read rulers** demarcated in 16ths of an inch, including reducing fractions
UM.10	**Read round meters** *(e.g., pressure meters)* and **straight meters** *(e.g., thermometers)*, including negative values

UM.11	**Interpolate** values of minor tick marks and to determine the value of the meter if reading in between tick marks
Complex Units	
UM.12	**Understand ratios** as a relationship between various unlike units, and can be either standard units to other units *(e.g., 2 feet/box)* or between two non-standard units *(e.g., 20 cans per box)*
UM.13	**Create ratios** from written scenarios, and use those ratios as conversion factors *(e.g., if a bookcase can hold 50 books per 5 shelves, the conversion factor of 10 books/shelf can be used to determine how many books can fit on 15 shelves)*
UM.14	**Understand rates** as a relationship between any unit and a time unit *(e.g., 30 miles per hour, or 50 heartbeats per minute)*.
UM.15	**Create rates** from written scenarios, and use those rates as conversion factors *(e.g., if you measure a heartbeat for 2 minutes and count 100 beats, the conversion factor of 50 beats per minute can be used to determine how many heartbeats will occur in 5 minutes)*
Analysis of Unit Requirements	
UM.16	Understand the **equivalence of inverse units** *(e.g. 20 tons per hour is equivalent to one hour per 20 tons)*
UM.17	Analyze written fictional scenarios to **determine possible units for solutions**, including scenarios with lengths, weights, volumes, areas, rates, and ratios *(e.g., "how far can a Gorbrer travel in an hour?" could have an answer in miles or centimeters, but not in inches/hour)*
Planning of Complex Conversions	
UM.18	**Plan chains of complex conversions** of up to 5 simple conversions from a set of conversion factors, including distractors *(e.g., create a conversion chain from trees to books by using conversion factors of logs/tree, sheets/log, and books/sheet)*

Data and Information

CSM's data and information content covers skills and intuitions for analyzing data, using data for predication, thinking through the relevance of data for various problems, and extracting data from a variety of information sources.

Measures of Central Tendency	
DI.1	Understand the importance of **averages as a measure of central tendency,** and **calculate averages** from data sets
DI.2	Understand the importance of **medians as a measure of central tendency,** and **calculate medians** from data sets
DI.3	Calculate **range** from data sets
DI.4	Determine **outliers** in data sets
DI.5	Understand **which measures of central tendency are most affected by outliers** (i.e., averages are sensitive to the removal of outliers while median and mode are not)

Outliers	
DI.6	Evaluate **outlier data points** to determine whether they should be removed or examined more carefully, given the goals of the data analysis
Using Data for Prediction	
DI.7	**Use averages as rates to predict future values** *(e.g., use a data set of car sales by month to calculate an average number of cars sold per month, and use this average to predict the number of car sales over the next 6 months)*
DI.8	**Use past rate data to predict future rate data** *(e.g., given a data set of error rates for various types of manufactured products (6 miscolored teddy bears out of 5300 teddy bears), predict how many teddy bears will be miscolored in a run of 10,000 teddy bears)*
Information Sources	
DI.9	Extract information from **bar charts**, including **interpolation** between ticks on the y-axis and charts with multiple data sets represented.
DI.10	Extract information from **line graphs**, including **interpolation** between ticks on the y-axis and graphs with multiple data sets represented.
DI.11	Extract qualitative data information from line and bar graphs without labeling on the y-axis, including identifying **maxima, minima, equivalence, trends**, etc.
DI.12	Extract information from **complex tables**
DI.13	Given descriptions of a complex dataset, determine **appropriate columns and rows** for a table according to the information to be extracted, including the distinct meaning of rows *(items)* and columns *(fields)*
Information Relevance	
DI.14	Determine **which pieces of information are relevant** to answering a specific question by asking whether the answer would change if the information were different. Understand that different questions will have different relevant information by asking multiple questions about the same information set.
DI.15	Determine the **relevant information to include when reporting a problem**, including a concise description of the object having the problem, what is going wrong, what happened before the problem happened, and what you have tried to do to fix the problem

Financial Calculations

Financial Calculations problems prepare students for real-world scenarios, including personal finance (interest, taxes, choosing financial products) and business decisions (uses of terms such as revenues, profits, etc.).

Taxes and Discounts	
FC.1	**Apply taxes and discounts** to prices, including the concept of sales tax and sequencing of discounts and taxes
FC.2	**Fill in invoices** including multiple items, discounts, and taxes

Interest	
FC.3	Calculate **simple interest**
FC.4	Understand that **interest on debts makes the debts larger** *(and is bad for your financial future)*, while **interest on positive account balances increases those balances** *(and is good for your financial future)*
FC.5	**Calculate compound interest** over multiple time periods, and recognize that small differences in interest rates grow dramatically over time.
Choosing Financial Products	
FC.6	**Compare financial options** to determine the best option *(e.g., if a day pass to a gym costs $15, and a membership costs $100 but reduces the cost per visit to $5, how many visits do you have to make to the gym to make it a better deal to buy the membership?)*
Business Calculations	
FC.7	Understand the relationships between **common business calculations** *(e.g., profit, revenue, expenses, assets, and liabilities)* and how to calculate them

Mathematical Applications

Mathematical Applications cover a range of topics related by the need for deep understanding of a problem and carrying out complex tasks carefully. These skills require broad numerical agility and fluency.

Time Calculations	
MA.1	**Calculate elapsed time** between two times, including over day boundaries
MA.2	**Use complex time schedules** to determine arrival times *("If you get to the Rose Road bus stop at 4:22pm, when will you arrive at Iris Avenue?")* and necessary departure times *("If you need to be at Iris Avenue by 5:30pm, when will you need to catch the bus at Rose Road?")*
Areas and Perimeters	
MA.3	Calculate the **area and perimeter of rectangular shapes**
MA.4	Calculate the **area and perimeter of complex shapes** by decomposing into simpler shapes
Person-Hours and Work Requirements	
MA.5	Understand the concept of **person-hours as a unit of work**, and use this to calculate number of people or number of hours for a given task *(e.g., if a job takes 5 person-hours, it can be accomplished by one person working for 5 hours, or 5 people working for 1 hour)*

Problem Solving

CSM equips students with specific problem-solving strategies and the problem-solving mindset to help them tackle real-world challenges. Students learn how to plan a solution to complex problems before jumping into execution.

Chunking and Sequencing	
PS.1	Understand the problem-solving strategy of **chunking**, identify scenarios where it is useful, and apply the strategy *(e.g., multi-step problems that require combining information)*
PS.2	Understand the problem-solving strategy of **working backwards**, identify scenarios where it is useful, and apply the strategy *(e.g., start with what you are trying to find and determine how you would find it, rather than starting with many pieces of information and trying to combine them)*
Units in Problem Solving	
PS.3	Understand the importance of **units in problem-solving**, and outline steps for complex multi-step problems by calculating the units that are in use at every step. **Check your answers to problems using units** (final answer units should align with the type of units in the question)
Logical Operations	
PS.4	Analyze **complex nested logical requirements** using AND, OR, NOT, <, <=, >, >=, and X OF Y operations
PS.5	Analyze **simple and complex logical requirements in conditions of uncertainty**, where there is not enough information to answer the question (including answer choices of "yes", "no", and "not enough information")
PS.6	Perform **inferences from written text** that require combining information across sample memos. Problems will use both known categorial information "Drugs with tricoloquine are in Schedule 49", and default categorical information "All other drugs are in Schedule 101-B"

Symbolic Thinking

Symbolic Thinking introduces the concepts of variables and equations.

Properties of Equality	
ST.1	Understand and use the **properties of additive, subtractive, multiplicative and divisive equality** (performing the same operation to both sides of an equation preserves equality)
Isolating Variables through Inverse Operations	
ST.2	**Isolate variables** through two-step process involving properties of equality
Distributive Property	
ST.3	Apply the **distributive property**
Understanding Formulas	
ST.4	Determine **equation properties** – e.g. whether a dependent variable will increase or decrease when an independent variable increases or decreases
Mathematical Modeling	
ST.5	Create **formulas from written scenarios** (linear, conversions, inverses)
ST.6	Find points of equality through solutions to **systems of equations** (break-evens)

Linear Equations	
ST.7	Graph linear equations
ST.8	Identify and use slopes and intercepts
ST.9	Understand how slopes and intercepts relate to real-world scenarios